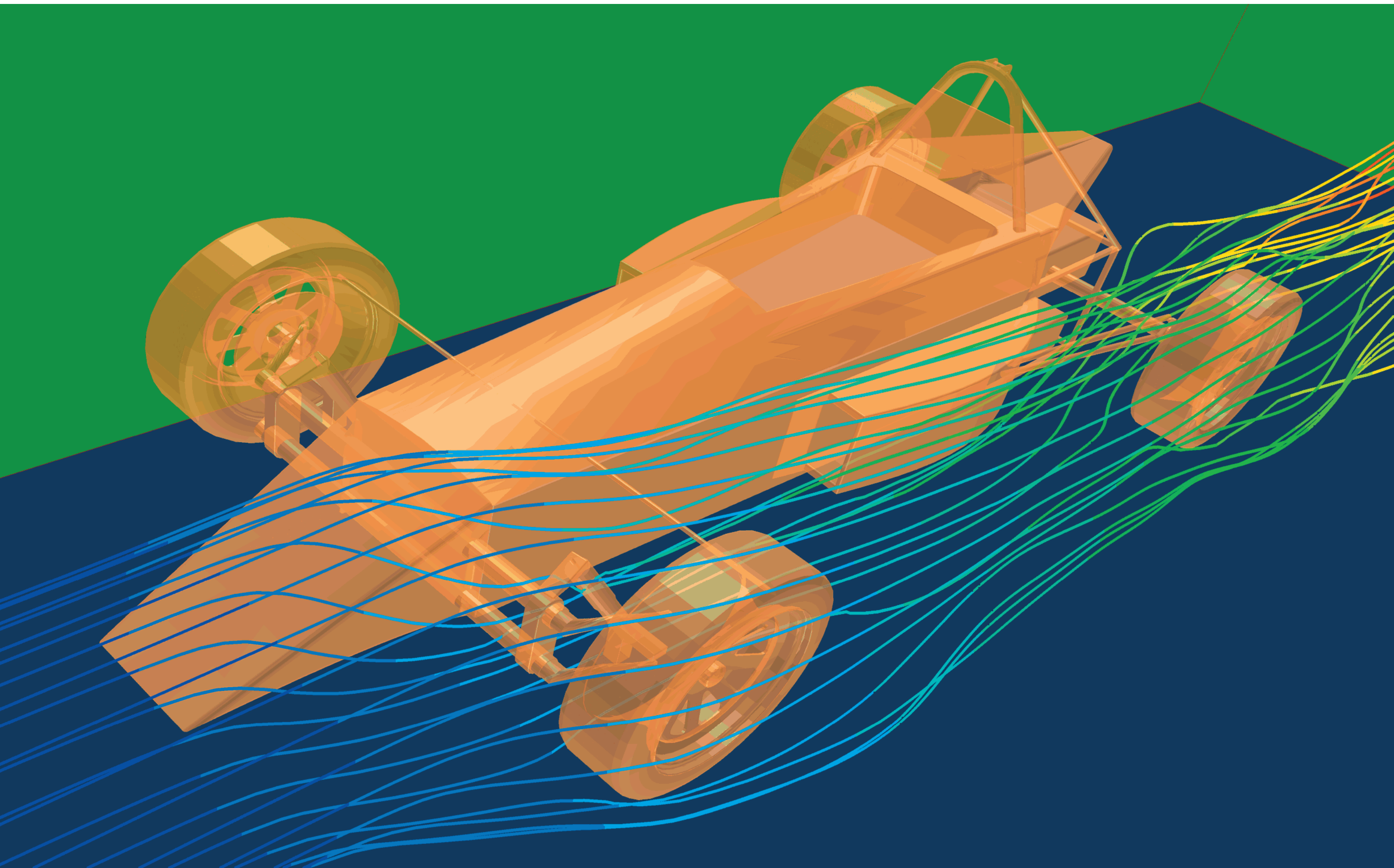
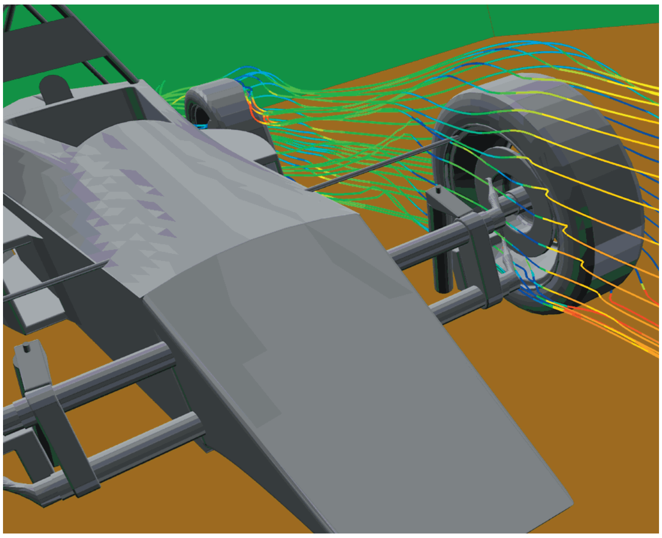
PHOENICS Virtual Wind Tunnel



PHOENICS VWT

PHOENICS VWT (Virtual Wind Tunnel) is a software package aimed at motorsport applications. The VWT uses mathematical techniques of computational fluid dynamics (CFD) to simulate any process involving fluid flow (in this case air). CFD packages have been available for many years but have, traditionally, been the preserve of big-budget teams due to the computing power required, the cost of the software, and the skills necessary to use it.



The increasing affordability of powerful desk-top computers removes one barrier and development of the available software allows engineers who are not CFD specialists to make use of the tool. Carrying out aerodynamic simulations that provide lift and drag information to influence decisions on design before physical testing is, therefore, a practical option.

It is often not possible to validate specific designs in a wind tunnel, either due to cost or time constraints. In this case PHOENICS has been demonstrated to provide results that agree closely with physical tests across a wide range of applications providing that the geometry of the electronic model is accurate and that care is taken when setting the grid and system parameters.

One of the main aims of the VWT is to simplify the initial set up of a case to provide realistic results. The VWT's VR-Editor is an interactive environment to load a particular design and set the parameters to be used for the computation. Results can be visualized within the VWT's VR-Viewer after the case is run. The display tools available include vectors, contours, iso-surfaces, and streamlines for both velocity and pressure. The forces on the vehicle body are also calculated to produce information on lift and drag.

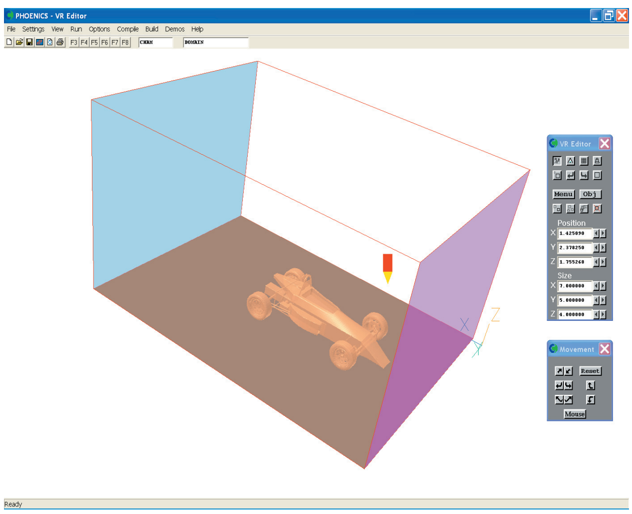
SETTING UP VWT

Domain Size

The cross sectional area of the domain (the volume within the red lines) can be adjusted to ensure that the walls of the domain do not have an undue influence on the geometry under test. It is accepted practice that the geometry under test should be no more than 5% to 7.5% of the total cross-sectional area.

Test Velocity.

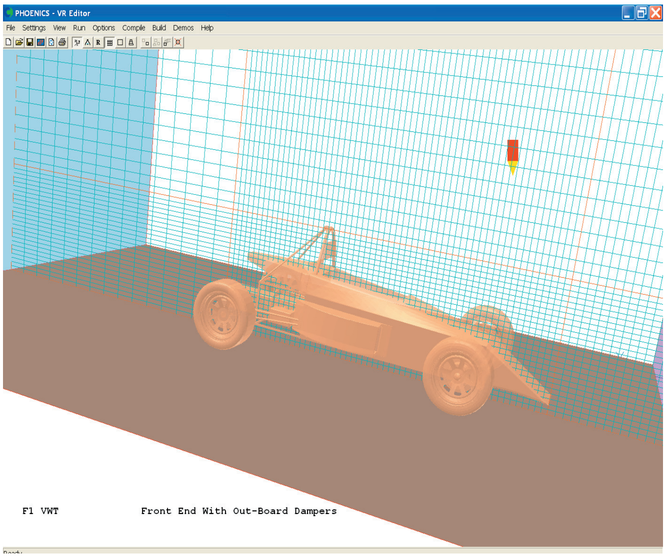
The test velocity is set for both the inlet and the road. Setting a velocity for the road ensures that ground effects can be analysed and provides a similar function to that of a moving road or driven belt that would be found in a wind tunnel.

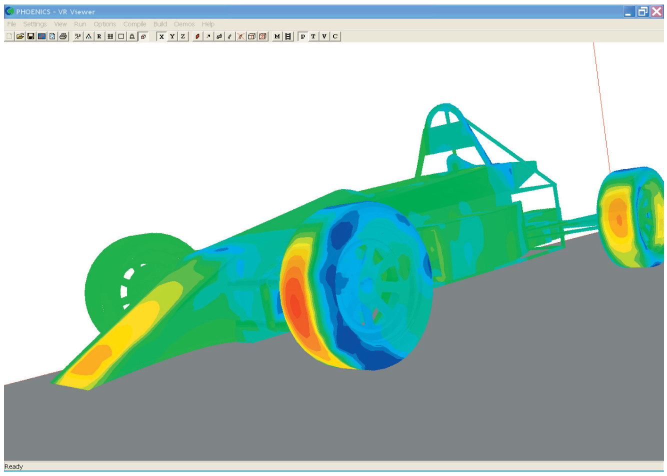


Grid

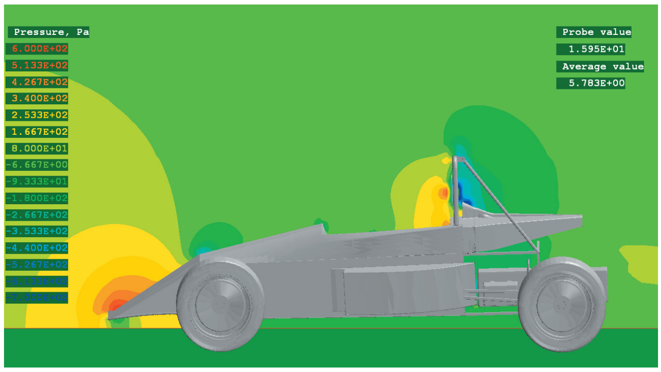
PHOENICS creates the initial grid sections around the geometry as shown below by the red boundary lines. The user can decide which areas require detailed analysis by defining the density of the grid shown in blue. Additional grid refinement can be added to provide further detail in particular areas if required.

A unique feature of PHOENICS is PARSOL (PARtial SOLid), a technique for improving the accuracy of flow simulations at the point where the fluid/solid boundary intersects some of the cells in a Cartesian (x,y,z) grid. This allows the use of a simple Cartesian grid around a body of complex shape without the need to create complex Body-Fitted-Coordinate or Unstructured-Grids.





Surface Pressure Distribution



The above shows the pressure distribution in the direction of flow. The red zone at the front of the car indicates an area of high pressure, while the blue behind the roll bar is an area of low pressure.

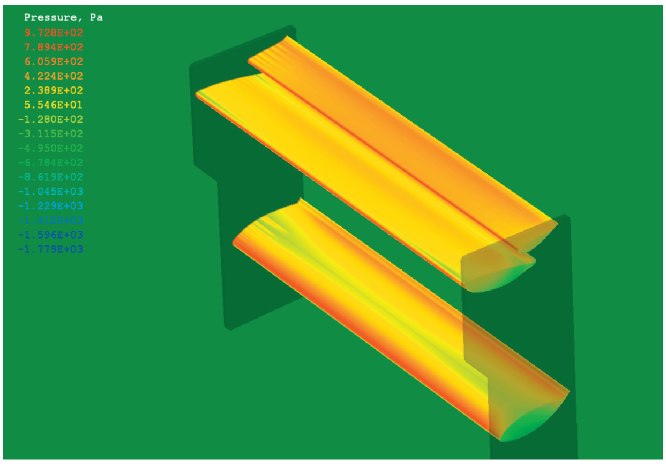
Results

A wide range of visualisation tools are available to present the results including the pressure distribution over a surface as shown above. Pressure or velocity profiles can be shown in the X, Y or Z axis and animated stream lines can be produced to aid the visualisation of flow over a particular section.

In addition to flow visualisation the following data are calculated and stored in a results file…

- Calculation of forces in X, Y, Z directions
- Coefficient of lift, drag and side force.

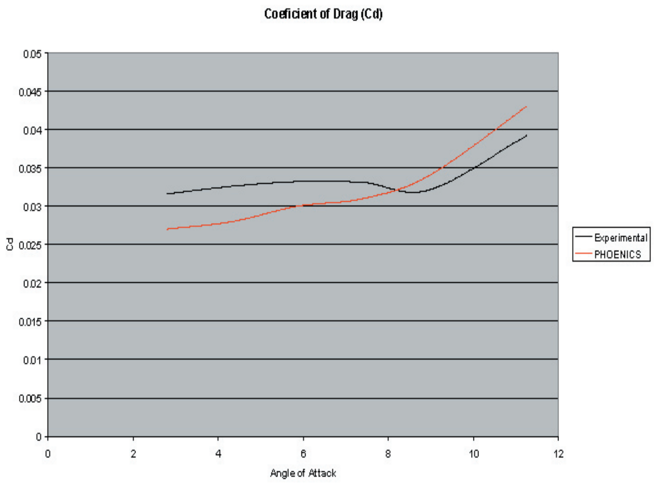
The calculated figures are an invaluable aid when comparing the changes in lift and drag across different designs.



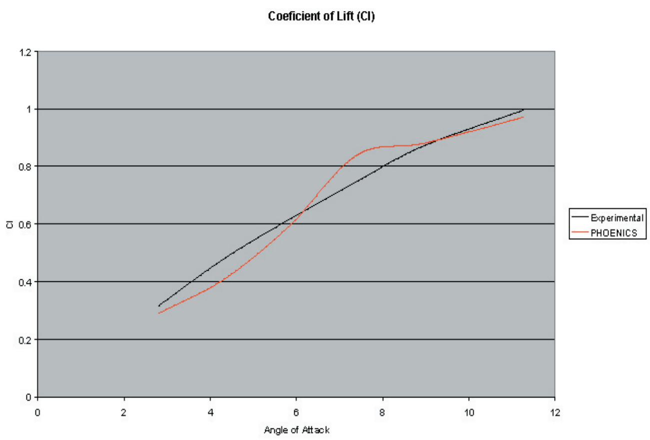
F3 Rear Wing Assembly

Validation

PHOENICS has been validated by many organisations, both industrial and academic, over a range of different flow situations including air flow around buildings and the development of a diffuser for a wind turbine. The following example case is based around the NACA2414 airfoil at a Reynolds Number of 60200 for which theoretical and experimental data are available. The model is 2D, using a grid of 180 x 140.

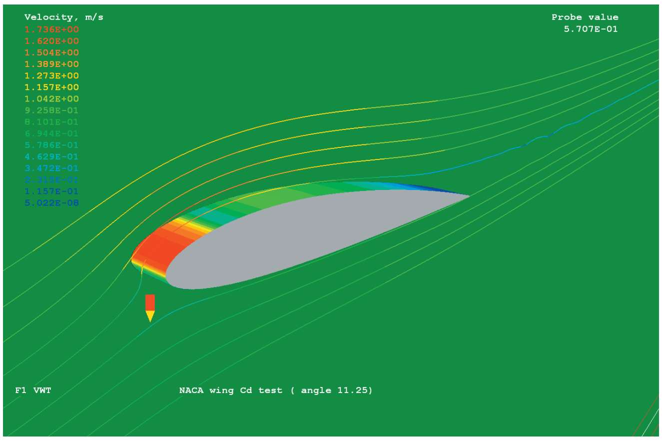


Coefficient of Drag (Cd) vs angle of attack



Coefficient of Lift (Cl) vs angle of attack.

The results for lift and drag compare very favourably with experimental data. The results are as good as, and in some cases better than, those from dedicated airfoil codes.



Streamlines around a NACA2414 airfoil

Additional validation papers are available from CHAM for a range of different cases.

System Requirements

The VWT can be run on any ‘standard’ PC running Windows. The software is CPU and RAM intensive, so the more power that is available, the faster it will perform. A 1GHz system with 512Mb RAM is a minimum requirement.

The VWT is able to accept designs created using a wide range of CAD software as both STL (3D object-based solid models) and dxf-file formats are catered for. Alternatively a 3D-modeling package such as Shapemaker or AC3D can be supplied by CHAM. There are also a number of companies who can provide 3D scanning facilities on a job-by-job basis.

For further information contact CHAM on 020 8947 7651 or e-mail Sales@CHAM.co.uk